

REMARKS

Claims 8, 13 and 17 have been canceled. Thus, claims 1, 2 and 9-11, 14, 15, 18 and 19 remain pending for further prosecution in the present application. Applicant submits arguments for overcoming the rejections over the prior art of record. Accordingly, Applicant respectfully submits that the present application is in condition for allowance.

I. Claim Rejections - 35 USC §112

In the non-final Office Action dated April 12, 2010, claims 8-10, 13-15 and 17-19 are rejected under 35 USC §112, first paragraph, as failing to comply with the written description requirement.

Claims 8, 13 and 17 have been canceled. Applicant respectfully requests reconsideration and removal of the above referenced §112, first paragraph, rejection.

II. Claim Rejections - 35 USC §103(a)

A. In the non-final Office Action dated October 13, 2009, claims 1-2, 8-11, 13-15 and 17-19 are rejected under 35 USC §103(a) as being obvious over U.S. Patent Application Publication No. 2003/0062261 A1 of Shindo.

Independent claims 1, 2 and 11 of the present application require a hafnium material having a zirconium content of 0.1wt% (1,000wtppm) or less.

The prior art '261 Shindo publication discloses a hafnium material in Example 2 on Paragraph Nos. 0082-0095 with an impurity analysis before refinement shown in Table 3 (Paragraph No. 0088) and an impurity analysis after refinement shown in Table 4 (Paragraph No. 0089). According to this disclosure, the amount of zirconium (as an impurity) in a hafnium material is 3500ppm (0.35%). This is the level of purity taught to one of ordinary skill in the art by the prior art '261 Shindo publication.

The prior art teaching of 3500ppm (0.35%) is far greater than that required by the claims of the present application (i.e., a zirconium content of 0.1wt% (1,000wtppm) or less).

As clearly taught to one of ordinary skill in the art by the prior art '261 Shindo publication: (a) hafnium and zirconium have similar chemical properties; and (b) it is extremely difficult to chemically separate these elements. While the prior art '261 Shindo publication discloses that it is possible to achieve a zirconium content of 5000ppm or less, such as 3500ppm, the inclusion of zirconium in the high purity hafnium in itself is not considered or taught by the '261 Shindo publication as being problematic since a zirconium content of 5000ppm will not deteriorate the characteristics of semiconductors. Thus, the reduction to 1000ppm is not taught by the prior art '261 Shindo publication nor is there any motivation for reducing to this level for semiconductor manufacture. This is in direct contrast to the teachings of the present invention.

Another known use of hafnium and zirconium, other than that as a semiconductor, is as a reactor material. In use as a reactor material, hafnium and zirconium are known by one of ordinary skill in the art to have contradicting properties. However, even in this case, if the amount of zirconium in a high purity hafnium material is less than several percent, it is conventionally known that it is sufficient for use as a reactor material, despite this level of zirconium content. Accordingly, Applicant respectfully submits that even in the case where that is an effort to reduce zirconium content in a hafnium reactor material, the separation is known to be difficult and several percent of zirconium content is found acceptable.

Applicant respectfully submits that there is no prior art reference that teaches or provides a motivation to one of ordinary skill in the art to reduce zirconium content in a hafnium material to the extent required by the claims of the present application. Based on the prior art '261 Shindo publication and common conventional technical knowledge at the time the present

application was filed, there is no disclosure concerning a hafnium material having a zirconium content of 0.1% or less, nor is there any motivation for reducing zirconium beyond about 3500ppm. For this reason, Applicant requests objective reconsideration of the above stated rejection and removal of the rejection.

In addition to limited zirconium content, independent claims 1, 2 and 11 of the present application require a hafnium material having an oxygen content of 40wtppm or less and dependent claims 9, 14 and 18 further limit oxygen content to 10wtppm or less.

The prior art '261 Shindo publication discloses reducing oxygen content from 500ppm to 120ppm based on "electron beam melting" refining techniques. This clearly does not reach the level of 40wtppm or less or 10wtppm as claimed in the present application and "electron beam melting" cannot be used to reach this level.

In contrast to the prior art '261 Shindo publication, the present invention reduces oxygen by performing "molten salt electrolysis" and only thereby achieves an oxygen content of 40ppm or less. More specifically, the molten salt of Ca and CaCl_2 is used and hafnium is reduced (deoxygenized) based on electrolysis (not electron beam melting as taught by the prior art '261 Shindo publication).

There is no prior art reference of record in the present application that discloses a deoxygenation method based on molten salt (according to the present invention) for hafnium. There is a good reason for this. Electrodeposited hafnium subject to molten salt is extremely brittle and will fracture if subjected to a pressing operation needed to form an ingot or sputtering target. Thus, the hafnium cannot be formed into a "lump" of material even if subjected to pressing processes. In the preparation of a sputtering target, it is important to be able to form a "lump" of material subject to pressing processes.

Materials that are typically subject to deoxidation processing based upon molten salt have properties permitting easy pressing of such material. For example, such a method may be applied to titanium since titanium can be easily pressed and subjected to such pressing (i.e. it is not brittle). Thus, titanium and hafnium are substances that are more different than might first be surmised. It is important to be able to form a lump of the material via pressing techniques, and in the case of electron beam melting, there is an intractable problem in that the material necessarily must be formed into a block shape in such a manufacturing process.

Moreover, electrodeposited hafnium contains numerous nonvolatile gases (Na, K, Cl, etc.), and there is a problem in that splashes will occur and deteriorate the production yield. Thus, conventionally, the actual process used and found acceptable for manufacturing hafnium was plasma arc melting, not electron beam melting.

The reason why the present inventor adopted molten salt electrolysis for manufacturing high purity hafnium is because the inventors determined it necessary to reduce the oxygen in the hafnium as much as possible and because the present inventor discovered that molten salt electrolysis, which was conventionally avoided for hafnium, was the best route to accomplish this objective.

Needless to say, molten salt electrolysis entails a disadvantage. Specifically, it is not possible to prepare an ingot for electron beam melting by simply applying pressing treatment to hafnium, which would otherwise be possible for materials such as titanium. Nevertheless, as long as there is an object of manufacturing high purity hafnium, even with the foregoing disadvantage of brittle non-press-able material, the present invention provides an optimal means which does not exist and was not disclosed in conventional technology for processing hafnium material.

One of the primary objectives of the present invention is to reduce oxygen. In the present invention, deoxidation is performed based not on electron beam melting, but on molten salt electrolysis. This is a clear difference between what one of ordinary skill in the art is taught by the prior art '261 Shindo publication and what the present invention requires. One of ordinary skill in the art following the teachings of the '261 Shindo publication cannot reduce oxygen content to 40wtppm or less nor does the '261 Shindo publication provide any motivation for such reduction. For this additional reasons, Applicant requests objective reconsideration of the above stated rejection and its removal.

As described above, the prior art '261 Shindo publication does not in any way disclose that "a hafnium sponge raw material is subject to solvent extraction and thereafter melted, and the obtained hafnium ingot is further subject to deoxidation based on molten salt electrolysis. Even if it is possible to separate zirconium from hafnium to a certain degree, or even if it is possible to eliminate oxygen contained therein to a certain degree, the problems cannot be resolved by one of ordinary skill in the art based on prior art teachings at the time of the invention. Applicant respectfully requests reconsideration and removal of the rejection.

B. In the non-final Office Action of April 12, 2010, claims 1, 2, 8-10 and 17-19 are rejected under 35 USC §103(a) as being obvious over ASM Handbook Volume 2, pp. 1093-1097.

The ASM Handbook relates to chemical vapor deposition and discloses that refining is possible with an iodide pyrolysis method. The descriptions in the ASM Handbook specifically relates to titanium, zirconium and chromium. Hafnium is merely vaguely listed within a list of other elements such as Th, V, Nb, Ta and Mo and no specific description is made with respect to the purity of Hf.

Moreover, the ASM Handbook provides the following description: “If a starting material with low iron content is used, its condensed vapor should reach a purity of 99.999%”. However, one of ordinary skill in the art would be well aware that there is no scientific basis on which the same results would be expected for all metals. The manufacture of high purity hafnium is technology that is much more difficult than other metals and the same results would never be expected by one of ordinary skill in the art.

The hafnium claimed by the present application has an extremely low zirconium content (1000ppm or less) and an extremely limited oxygen content (40ppm or less, or 10ppm or less). The ASM Handbook provides no such teaching for hafnium. The ASM Handbook also fails to acknowledge the problems concerning removal of phosphorus and sulfur. Accordingly, it would be erroneous to conclude that the present invention could have been easily conceived by one of ordinary skill in the art at the time of the invention based on the disclosure provided by the ASM Handbook.

As described above, the ASM Handbook does not in any way disclose that “a hafnium sponge raw material is subject to solvent extraction and thereafter melted, and the obtained hafnium ingot is further subject to deoxidation based on molten salt electrolysis. Even if it is possible to separate zirconium from hafnium to a certain degree, or even if it is possible to eliminate oxygen contained therein to a certain degree, the problems cannot be resolved by one of ordinary skill in the art based on prior art teachings at the time of the invention. Accordingly, Applicant respectfully requests reconsideration and removal of the rejection.

III. Conclusion

In view of the above amendments and remarks, Applicant respectfully submits that the claim rejections have been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

Please charge any deficiency or credit any overpayment for entering this Amendment to our deposit account no. 08-3040.

Respectfully submitted,
Howson & Howson LLP
Attorneys for Applicants

By /William Bak/
William Bak
Reg. No. 37,277
501 Office Center Drive
Suite 210
Fort Washington, PA 19034
(215) 540-9216